Publication No. 52
Minimum Competencies
Series (T) 4

MINIMUM VOCATIONAL COMPETENCIES BASED CURRICULUM

AIR CONDITIONING AND REFRIGERATION

Vocationalization of Education Unit
National Council of Educational Research and Training
Sri Aurobindo Marg, New Delhi - 110016

CONTENTS

Page No.

Introduction 1 - 2

1. Job Opportunities 3

2. Comprehensive Job Description ... ... 4 - 5

3. Task Analysis ... ... 6 - 11

4. Course Objectives 12

5. Proposed time allocation 13

6. Recommended structure of the course with time distribution and marking scheme. ... ... 14 - 15

7. Syllabus ... ... 16 - 39

8. List of equipments ... ... 40 - 42

9. Suggested reading materials ... ... 43 - 48

INTRODUCTION

Many states have introduced Air conditioning and Refrigeration as one of the vocational courses at the higher secondary stage of education. However, the existing curriculum of this course is more of academic nature than of practical nature based on the job requirement of the vocation, It is, therefore, necessary to identify minimum competencies needed for carrying out the responsibilities of Air conditioning and Refrigeration effectively and make it the basis for curriculum development.

When learning deals with performance type of activities, it is necessary to have an analysis of each job to be performed. Otherwise it will be impossible to identify and assemble a core of essential skills and related knowledge which will achieve desired goals. Furthermore, manipulative operations require a certain sequential order of performance. Therefore, teaching content must have a psychological and methodical manner of presentation, Thus, identification of minimum competencies becomes an essential exercise before designing and planning suitable curricula for vocational subjects. The procedure for this purpose may include following four steps:--

1. Disting of job opportunities
2. Identification of frequently performed duties under each job
3. Analysing the tasks or duties into knowledge, skills and personality traits.
4. Determining course objectives

Based on this the minimum competencies identified through the steps mentioned above, the curriculum has been developed.

The Vocationalization of Education of the N.C.E.R.T. organised a workshop at Technical Teachers' Training Institute, Bhopal from 20th December, 1983 to 24th December, 1983 for the identification of minimum Vocational Competencies in Air Conditioning and Refrigeration to spell out knowledge, skills, personality traits. In this workshop the jobs, duties and tasks

have been systematically analysed by a number of experts, field workers, teachers and curriculum farmers in order to identify minimum vocational competencies in the area concerned.

It is hoped that the present exercise of identifying the minimum vocational competencies in Air Conditioning and Refrigeration will prove useful for the students, teachers, teacher educators, curriculum planners and employers at large and will help in making the programme of vocationalization really employment oriented.

-: MINIMUM VOCATIONAL COMPETENCIES BASED CURRICULUM :-

Name of the vocation : Air Conditioning & Refrigeration

Job opportunities :

The following are job opportunities for those pursuing vocational course in Air conditioning and Refrigeration.

A. Wage Employment

A.1 Refrigeration and Air Conditioning Mechanic in service enterprise

A.2 Refrigeration and Air conditioning Mechanic in process enterprise

A.3 Sales and Service representative

B. Self Employment

B.1 Refrigeration and Air conditioning Mechanic (service engineer)

B.2 Sales cum service job

B.3 Sales of equipments and spares

Comprehensive job description/list of activity based on the job opportunity

1. To communicate effectively using regional languages
2. To locate the faults and rectify the defects
3. To estimate the cost and time required to carry out the job
4. To negotiate with the customer and procure the order
5. To carry out preventive maintenance.
6. To overhaul, dismentle, assemble and fit the compressor
7. To overhaul and assemble the whole system
8. To rewire the apparatus/system
9. To pressure test, vacuumise, flush, gas charge and test the whole system
10. To start and run the plant/system
11. To prepare project reports to start an exterprise
12. To establish own enterprise.

Sl.No.	TYPE OF JOB	CLASS OF JOB	
		WAGE EMPLOYMENT	SELF EMPLOYMENT
1.	2.		
1.	Refrigeration and Air conditioning Mechanic		
	a) Call service	1 to 5, 8, 10	1 to 5, 8, 10 to 12
	b) Workshop service	6 to 9	6 to 9, 11, 12
	c) Scales	--- --- ---	1, 4, 5, 11, 12
2.	Refrigeration & Air conditioning Mechanic in process or manufacturing industry		
	a) In industry	5 to 10	--- --- --- ---
	b) Sales and services	1 to 10	--- --- --- ---

TASK ANALYSIS (Identification of Knowledge, Skills & Personality Traits)

Sl.No 1.	JOB DESCRIPTION/ACTIVITY 2.	KNOWLEDGE 3.	SKILL 4.	PERSONALITY TRAITS 5.
1.	To communicate effectively using regional languages.	Working/elementary knowledge of the language	ability to speak ability to write	Good manners Patience Politeness Honesty and trustworthiness.
2.	To locate the fault and rectify the defects.	- Comprehension of working of system - Faults of various systems - Various electrical and Mechanical faults - Knowledge about various testing tools and instruments. - possible causes and diagnosis. - Taking suitable remedial measures	- ability to test with instruments and use various testing tools. - ability to detect the fault - ability to rectify the fault.	Accuracy Systematic confidence Perseverance Dependability Judgement Commonsense

1.	2.	3.	4.	5.
3.	To estimate the cost & time required to carry out the job.	Making estimate by knowing the prevailing market rates of various components/type of repairs duration of time required for repairs, service charges. Feasibility of repairs at site, at workshop.	Ability to perform repairs/replacements. Ability to rectify the electrical faults eg. supply connection, defective stablizer, thermostat, cutout relay etc at site. Ability to locate faults due to noise and vibrations eg. compressor repair (overhauling) Gas charging, Rewiring fittings etc.	Hard work sincerity
4.	To negotiate with customer and procure order	Comparative rates of components and service charges of various other competencies. Knowledge of cost versus relialility, contents of tool kit.	Ability to use the tools and instruments properly	Salesmanship

2.	3.	4.	5.
carry preventive Maintenance d periodical servicing	Knowledge of lubrication, cleaning/replacement of air filter etc. cleaning descaling of condenser cooling coil, levelling of condensers, lubrication of moving parts eg. motors, scheduling of preventive maintenance program of various system components, stores and inventory.	Ability to carry out preventive maintenance.	Sense of neatness and tidyness.
overhaul, dismantle, semble and fit the mpressor	Construction details and functions of various components of different types of compressors (hermetically sealed, open type etc.) Different types of windings and electrical connection. Properties of various types of common refrigerants F.12, F.22 etc. Lubrication types, specifications and quantity of the lubricant required for various types of compressors.	Ability to dismantle and assemble of the various components of compressors using appropriate tools and observing safety precautions.	Initiative promptness confidence, Accuracy Safety Habits Contd............. /

1.	2.	3.	4.	5.
		detailed procedure and precautions for dismantling and assembling of various types of compressors. - procedure & cutting and welding & hermetically sealed compressors including testing of electrical windings.		
7.	Overhauling/Assembly of whole system.	working principle of whole system - constructional details and working of individual components e.g. condenser, evaporator, thermostat, insulation, cabinet etc. - Making flares and connections for various tubes. Specifications of various special tools	Ability to Brzae & make flared connections. Ability to change insulation	Initiative promptness Confidence Accuracy Safety Habits.
8.	Reviewing of apparatus/system	Working principles and constructional details of electrical components eg. Relays, Thermostates etc.	Ability to test & set relays and thermostats and make suitable connections.	Safety Habits

Contd......... /-

1.	2.	3.	4.	5.
9.	Pressurising [illegible] flushing, gas charging and testing the whole system	- Various types of refrigerators specifications various types of refrigerants - their specifications and properties. - procedure for vacuum evacuation and charging of refrigerants - methods for detection and prevention of leakages.	Ability to use the refrigerant efficiently (without wastage).	Cautious Accuracy Efficiency
[illegible]	Starting and [illegible] of the system	- constructional details and working principle of system and its components eg. range of parameters viz pressure, temperature, humidity flow etc. - procedures for starting and stopping of various types of plants as per operation manual.	Ability to start and stop the plant as per operation manual Ability to measure and adjust pressure, temperature, humidity, flow etc. according to system specifications.	Dependability promptness Judgement Common sense

1.	2.	3.	4.	5.
11.	Preparation of project reports to start an enterprise.	- Preparation of project report considering market survey, feasibility, financial resources, economic viability taxation and levy of duties.	Ability to prepare project and feasibility reports, handle finances.	Interest & enthusiasm Leadership Confidence Perseverance Courteous & Cheerful Good speech habits
12.	Establishing the enterprise	Site selection, registration procedure procurement of tools and equipment. Knowledge about sales (tenders and quotations). Book keeping and accounts publicity, salesmanship - aptitudes and requirements potential suppliers and products - comparable quality and costs.		Interest and Enthusiasm Leadership Confidence Preseverance Courteous and Cheerful Good speech habits.

National Institute of Education
Library & Documentation
Acc. No F16634
Date 27.1.84

COURSE OBJECTIVE

-: CREATIVE (KNOWLEDGE) OBJECTIVES :-

1. To help students acquire the knowledge of :-

   (i) Receiving and attending the customers

   (ii) Ascertaining the faults and rectifying the defects.

   (iii) Acquiring the knowledge about working of system, various tools and instruments, possible causes and diagnosis, construction details and working of components.

   (iv) Estimating the cost and time required to carry out the job.

   (v) Acquiring the knowledge of lubrication, cleaning/ descaling of condenser cooling coil, scheduling of preventure maintenance.

   (vi) Acquiring knowledge of various components of different types of compressors, different types of windings and electrical connections.

   (vii) Acquiring knowledge about specification of various special tools.

   (viii) Acquiring knowledge abour refrigerants, charging of refrigerants, methods for detection and prevention of leakages.

   (ix) Acquiring knowledge about starting and stopping of various types of plants as per operation manual.

   (x) Preparing project report, considering market survey, feasibility, financial resources etc.

   (xi) Selection of site, procurement of tools and equipment, knowledge about sales (tenders and quotations) etc.

SKILLL OBJECTIVE

2. To help students in developing skills in

   i) receiving and attending the customers.

   ii) testing with instruments and use of various testing tools and instruments.

   iii) detection of the faults after analysis of symptoms.

   iv) verification of the faults

   v) carrying out preventive maintenance program

   vi) dismentling and assembling of the various components of compressors

(vii) Brazing and making flared connection.

(viii) testing and setting relays and thermostats and make suitable connections

(ix) using the refrigerant efficiently

(x) starting and stopping the plant as per operation manual

(xi) measuring and adjusting pressure, temperature, humidity, flow etc. according to system specifications.

(xii) preparation of project and feasibility reports and handle finances.

-: PERSONALITY TRAITS OBJECTIVES :-

3. To develop the personality traits such as

i) Accuracy, ability to get along with others, Hard work, sincerity, politeness, patience, honesty and trustworthiness, confidence, perseverance, dependability, salesmanship, sense of neatness, judgement, tactfulness, safety habits, initiative, efficiency, good speech habits

-: PROPOSED TIME ALLOCATION :-

Available hours per week in schools in our country is approximately thirty-three hours. In an academic year about thirty nine weeks are utilised for instructional purposes, because nearly thirteen weeks are earmarked for vacation (8 weeks), closed holidays (2 weeks), examination preparation (1 week), and conducting of examination (2 weeks). Hence, the time available for imparting instructions in an academic year is approximately

(33 X 39 = 1287) 1287 hours, say, 1200 hours.

RECOMMENDED STRUCTURE OF THE COURSE WITH TIME DISTRIBUTION AND MARKING SCHEME:-

A. Class - XI

Sl.No.	SUBJECTS	PERCENT TIME ALLOCATION	INSTRUCTIONAL HOURS	MARKS EXAM. MARKS (a)	MARKS SESSIONAL MARKS (b)	MARKS TOTAL MARKS (c)
1.	2.	3.	4.	5.		
1.	Language (Regional) I	10	120	100	--	100
2.	Language (English) II	10	120	100	--	100
3.	Basic Foundation Course	5	60	50	--	50
4.	General Foundation Course	5	60	50	--	50
5.	Vocational Theory - I	10	120	100	--	100
6.	Vocational Theory - II	10	120	100	--	100
7.	Vocational Theory - III	10	120	100	--	100
8.	Vocational Practical - I	12.25	150	100	25	125
9.	Vocational Practical - II	15.0	180	100	50	150
10.	Vocational Practical - III	12.25	150	100	25	125
	TOTAL :-	100	1200	900	100	1000

It is recommended that the student should be attached with the nearby industry for on the job training and the concerned vocational teacher should supervise the performance of the students.

Class - XII

Sl. No.	SUBJECTS	PERCENT TIME ALLOCATION	INSTRUCTIONAL HOURS	MARKS		
				EXAM. MARKS (a)	SESSIONAL MARKS (b)	TOTAL MARKS (c)
1.	2.	3.	4.	5.		
1.	Language (Regional) - III	10	120	100	--	100
2.	Language (English) ¾ IV	10	120	100	--	100
3.	Basic Foundation Course	5	60	50	--	50
4.	General Foundation Course	5	60	50	--	50
5.	Vocational Theory - IV	10	120	100	--	100
6.	Vocational Theory - V	10	120	100	--	100
7.	Vocational Theory - VI	10	120	100	--	100
8.	Vocational Practical - IV	12.25	150	100	25	125
9.	Vocational Practical - V	15	180	100	50	150
10.	Vocational Practical - VI	12.25	150	100	25	125
	TOTAL :-	100	1200	900	100	1000

Vocational Theory II and Vocational Practical II are core of the Vocation in class XI and Vocational Theory V and Vocational Practical V are core of the Vocation in Class XII.

On completion of the course the students should be placed as an apprentice with nearly industrial establishment for a period of one year.

SYLLABUS FOR THE VOCATION

VOCATIONAL THEORY - I

BASIC ENGINEERING

Class XI

Max. Marks 100

Instruction time :
120 Hours

Part A

- FUNDAMENTALS OF UNITS :- Various types of units C.G.S./M.K.S./S.I units
- FLUID AND PRESSURE :- Definition of Pressure, Vacuum-head, Density, specific gravity, specific volume velocity, Flow/ Discharge for fluids.
- HEAT :- Change of state of fluids, sensible heat, Temperature of formation of vapour, Latent heat of vaporisation and Fusion, specific heat of gases, expansion and contraction, sublimation and Evaporation,
- ENERGY :- Force, Work, Power & Energy.
- THERMODYNAMIC LAWS AND PROCESSES :- First Law and Second Law of Thermodynamics, Boyle's Law, Charle's Law and Gas Equation.
- ELEMENTARY HEAT TRANSFER :- conduction, convection, Radiation, Thermal Conductivity, Refrigeration Effect, Concept of "Ton" as applied to Refrigeration.

PART - B ELECTRICAL ENGINEERING

1. FUNDAMENTAL CONCEPTS & PRINCIPLES :-

(a) Importance of electricity in modern life, Various effects of electric current utilised e.g. megnetic, chemical and heating effects and their applications.

(b) Different types of electrical engineering materials i.e. conductors, insulators, semi conductors and magnetic and their uses.

(c) Electric current as flow of electrons, potential, potential-difference(hydraulic analogy), Resistance : their difinitions and units, Ohm's law and its applications.

(d) Work, Power & Energy - Definitions, units and simple problems.

2. ELECTRIC CIRCUITS :- Kirchoff's laws, Equivalent resistance of series, parallel and series-parallel combination of resistance, solution of simple D.C. Circuits for finding currents, voltage drops etc.

3. Concept of Inductance and capacitance, Expression of inductance and capacitance in terms of their physical parameters, self and mutual inductance, series and parallel connections of capacitances. Finding out equivalent values, practical applications of inductance and capacitors.

4. ELECTROMAGNETISM AND ELECTROMAGNETIC INDUCTION :-

Magnetic field, flux and fluxdensity, force on a current carrying conductor, Analogy between electric and magnetic circuit.

Faraday's Laws of electromagnetic induction, Lenz's law, concepts of statically & dynamically indduced emfs and self and mutally induced emfs, co-efficient of coupling.

5. ELECTRIC SUPPLY SYSTEM :-

(a) Single line diagram of a supply system showing power-flow from Generating station to consumer premises.

(b) Direct and Alternating currents, Instantaneous value, cycle frequency and time-period of alternating quality, Generation of a sine-wave and its instantaneous, maximum, average r.m.s. Values, Form-factor and peak factor, simple numerical problems.

(c) Alternating current circuit (1-Ø) : Series and parallel circuits containing R,L and C, Determination of current, voltage drops, power and power factor etc. in those circuits.

(d) Production of single-phase and three phase voltage star and Delta connections of three-phase windings, Relationships between Phase and Line values of currents and Voltages in case of Star and Delta connections.

(e) Applications of D.C., D.C. Voltage supplies.

6. ELECTRIC WIRING :-

(a) Graphic symbols for electrical quantities and items.

(b) Wires and cables, classification, designation and colour code, Standard wire gauge, wiring accessories like switches, lampholders, plugs, fuses and distribution boxes, Different types of wiring, Wiring diagrams for 1 point controlled by one switch, 1 point controlled by two switches (staircase wiring) and Godown wiring.

(c) Fuse - Function, materials and advantages of fuse, Rated current, fusing factor and fuse-constant, Rewirable and high rupturing capacity (H.R.C.) cartridge fuses.

7. UTILISATION :-

(a) Different types of electric lamps (namely Filaments, fluorescent, mercury vapour and sodium vapour lamps) and their applications.

(b) Classification of different types of D.C. and A.C. motors (1-Ø & 3-Ø), Applications of different types of motors, motor for specific applications.

Necessity of starters, starters for D.C. Shunt motor and induction motors both 1-Ø and 3-Ø.

(c) Transformer - function, principle, construction (core and shell tupe), e.m.f. equation and voltage & current ratios, concept of KVA rating, efficiency and regulation of transformer.

(d) Refrigeration & Air conditioning - Electric Circuit of a refrigerator, Thermostat and its working, common faults in refrigerators and their remedies, Electric circuits of an air conditioner and water cooler and their operation.

8. ELECTRICAL MEASUREMENT AND MEASURING INSTRUMENTS :-

Measurement of voltage, current and resistance by Multimeter, use of Megger for continuity and insulation-resistance measurement.

Connections of different meters i.e. Ammeter, Voltmeter wattmeter and energymeter in electric circuit; Permanent magnet moving coil and moving iron type ammeters and voltmeters, dynamometer type wattmeter and induction type energymeters.

9. ELECTRICAL APPLIANCES :-

(a) Voltage Stabilisers - function, types, Rating and connections in electrical circuit.

(b) Relays - Over-current and undervoltage relays, Thermal relays - principle of operation, ratings and connections

(c) Electric bell Automatic electric iron, Immersion heater and Geyser - Construction, principle of operation and their working.

10. EARTHING OF ELECTRICAL EQUIPMENTS :-

Necessity, Precautions to be observed while working with electricity, Electric-shock treatment.

VOCATIONAL PRACTICAL - I

ELECTRICAL LAB.

Total Marks - 125

Instructional time - 150 Hrs.

EXPERIMENTS :-

1. To make different types of cable joints e.g. straight joints T joints, Lugs filling, Thimble soldering.
2. Preparation of circuit boards as per symbolic circuit diagrams.
3. Use of different electrical measuring instruments e.g. Multimeter, Megger, earth-resistance tester, Ammeter, Voltmeter, wattmeter and energymeter.
4. Checking continuity in circuit with multimeter and finding out earth-resistance with earth resistance tester.
5. Preparation of testing boards having lamps in series and parallel.
6. Selection of type and rating of fuse for a givem load and requirement.
7. Checking, setting and connecting in the circuit Relays, Voltage stabilisers, circuit breakers, motor starter and thermostat controlled devices.
8. Determination of starting current (without using starter) and running current of motor.
9. Varification of Ohm's and Kirchoff's laws.
10. Verification of voltage and current relationships in phase and line values of star and delta connected system.
11. Fault finding in and rectification of electrical appliances.
12. Finding efficiency and regulation of transformer by direct loading

VOCATIONAL THEORY - II

REFRIGERATION

Total Marks : 100
Instructional Time : 120 Hrs.

1. INTRODUCTION :- Necessity and Prospects

Types of refrigeration systems. Units of refrigeration.

2. VAPOUR COMPRESSION SYSTEM :- Refrigerant Basic vapour compression cycle. Refrigerating effect and power required for compression (Theory only).

3. ABSORPTION REFRIGERATION SYSTEM :- Basic cycle and components. Advantages and limitations.

4. REFRIGERATION PIPING :- Refrigerant piping material copper tubing, copper tubing classification, cutting copper tubing, Tube bending, Methods of joining, Valves.

5. VARIOUS COMPONENTS OF VAPOUR COMPRESSION SYSTEM :-

   a) Compressors :- Types of compressors, constructional details of reciprocating compressors, centrifugal compressor, rotary compressor and hermetically sealed compressor. Their capacities and availability of different brands in the market. Assembling of compressors.

   b) Condensers :- Different types and their comparision. Air cooled, water cooled evaporators. Constructional details. Pumps required for circulating water. Type of pumps and power required. Cooling Towers, Force and natural draft types. Spray type water treatment for cooling water.

   c) Evaporators :- Different types of evaporators frost type, defrost type, Non-frost type, sheet and tybe type.

   d) Expansion Devices :- Different types capillary tube, thermostatic expansion value, Automatic expansion valve, constructional details and applications.

6. LUBRICATION :- Different lubrication methods used in refrigeration industry, specifications of lubricating oils and their quantities required for various types of compressors.

7. REFRIGERANTS :- Properties of different refrigerants (F 12, F 22, F 11, F 13, F 26, Ammonia CO_2, SO_2) Availability and market rates of refrigerants. Detection of leakage. Storing and handling of refrigerant cylinders, cylinder capacities. First aid. Secondry refrigerants. Brines.

8. CONTROL DEVICES :- Operating controls such as thermostats, relays, defrost control, Protective controls, temperature control, high pressure low pressure cut out. Solenoid valves.

9. INSTALLATION AND OPERATION :- Codes, Ordinances and standards; Equipment placing; Foundations Leveling, Installation of belt driven compressors. Installing direct driven compressors. Initial start up.

10. CHARGING OF REFRIGERANT :- Knowledge of refrigerant to be charged. Care to be taken for charging, charging unit, Refrigerant leakage, Methods of leak detection. Evacuating system. Distillers, Purging, Dehydration. Charging pressures.

11. APPLICATION OF REFRIGERATION :-

a) Refrigerators :-

Deep freesers, bottle coolers, candy machine :-

Types and specifications. Customers educations. Study of construction of cabinets and their doors. Deefrosting systems. Wiring diagram. Ice makers.

b) Cold storage :- Items to be stored in cold storage. Temperatures required for different food items. Preparation of food before freezing. Types of insulation used.

c) Water Coolers :- Different types, and their specifications. Water filters; cabinet construction.

VOCATIONAL PRACTICAL - II

Total Marks : 150
Instructional time : 180 Hrs.

-: BASIC REFRIGERATION :-

- Tube cutting instructions
- Tube Bending instructions
- Tube Flaring instructions
- Tube swaging instructions
- Tube Pinching instructions
- Tube soldering instructions
- Tube Brazing instructions
- Cut & thread G.I pipe
- Dismantling of Reciprocating compressor
- Assembling of Reciprocating compressor
- Dismantling of Rotary compressor
- Assembling of Rotary compressor
- Making of Gaskets for compressor parts.
- Lapping instruction
- Transfer of refrigerant into service cylinder from storage cylinder.
- Install Gauge Manifold in the system.

-: CONVENTIONAL REFRIGERATION SYSTEM :-

- Reciprocating compressor Testing
- Add oil to the compressor (open type)
- Draw vacuum in a Refrigerating system (open type)
- Charge Refrigerant in a conventional system
- Test leaks in a system.
- Remove & replace dehydrator
- Remove & replace sight glass
- Remove & replace capillary tube
- Test and adjust Automatic Expansion Valve.
- Test and adjust Thermostat
- Remove & replace Automatic Expansion Valve

- Purge air from the system.
- Remove refrigerant from a system.
- Test and connect Electrical system.
- Service Conventional Refrigerating system.

-: DOMESTIC REFRIGERATION SYSTEM :-

- Install and inspect Domestic Refrigerator
- Evacuate Hermetic System.
- Charge Hermetic System
- Add oil to Hermetic System
- Replace capillary tube in Hermetic system
- Replace Dehydrator in Hermetic System
- Clean & flush burn outs refrigerating system
- Replace Hermetic system.
- Test and check capacitor
- Test and check Relay
- Check & connect Hermetic Electrical system
- Service Domestic Refrigerator.
- Install & Inspect Freezer.

VOCATIONAL THEORY - III

-: WORKSHOP TECHNOLOGY AND DRAWING :-

Total Marks : 100
Instructional Time : 120 Hrs.

TRANSMISSION OF POWER :-

Types of drives, Velocity ratio, 'V' belt drives, Specification of 'V' belt and Pulley.

SAFTEY MEASURES :-

Protective clothing, face shields, facepad, hand gloves, insulated tools and appliances, safety from fires, fire-extinguishers, precautions for lifting and carrying heavy loads, Use of lifting tackles/pulley/blocks. Handling aids like levers, trollies, first aid materials.

GENERAL HAND TOOLS :-

Description function and specifications of screw drivers, spanners, vices, hacksaw files, hammers, mallets, carborandum mallets, taps, dies, pipe dies, insulated pliers, phase tester and test lamps.

GENERAL POWER TOOLS :-

Portable electric drill, bench type drill, Hand grinder, Use of centre lathe for cutting the outer casing of compressors.

REFRIGERATION AND A/C TOOLS :-

Flaring block, Flaring yoke, pinching off tool. Hand shut-off valve, Halide torch, Gas charging line, gauge manifold, Gas charging station, suction key, blow lamp.

CARPENTRY :-

(a) Properties and Defects :- Teak wood, cutting planks and battens from logs.

(b) Wood Working Tools :- Marking gauge, hacksaw, tension saw, square, cutting of wood along and across the grains.

Hand Plane :- Construction and operation of chiesels, files, knives.

Safety precautions while using hand tools, Hand drill and twist drill Hammers, wooden mallet, vices, power tools like band saw circular saw, Jig saw, and safety precautions while using these. Use and specifications of

different wood screws and nails. Use of differnt adhessive like fevicol and araldite.

Constructional details of different types of joint like Rabbet joints, Dado and Rabbet joint, Dado and Lap joints.

Specification and use of commercial plyboards, hardboards.

- SHEET METAL WORKING :-

(a) Uses and specifications of different types of sheet materials like black sheet, galvonized sheet and allu-minium sheets.

(b) Sheet Metal working tools :- Mallets, hammers, carbo-randum mallets, vice, bending edges, a rail piece, M.S. base plates, chisels, punches hand shears, and lever operated shears, Bench stakes.

(c) Sheet Metal Joints :- Different types of sheet metal joints, like Grooved lock seam, Hammered lock seam, Pittsburgh lock, corner double seam,

Hem :- Single hem, double hem, standing hem.

PROCEDURE FOR PREPARATION OF ROUND AND RECTANGULAR DUCTS :-

Preparation of reducer. joint for a rectangular ducts.

- Soldering Brazing and Welding :- Composition of solders, fluxes, and soldering of copper and brass on G.I. sheet. Soldering of G.I. sheet joints.

Brazing :- Process details, use of blow Lamp, gas torch, filler rod, fluxes, precautions while brazing copper/brass on G.I. sheets.

Welding :- Types of welding processes, Arc and Gas welding.

Gas welding :-Oxy-acetyelene gas welding torch, types of flames, adjusting gas valves for correct flame, filler rods and fluxes. Precautions while gas welding, Gas welding of M.S. sheets, using leftward and rightward welding, Different types of gas welding joints.

Arc Welding :- Principle of Arc welding, Arc welding using single phase welding transformers, specifications of weld-ing electrodes, use of electrodes coating materials, Butt and Lap joints by arc welding, Selection of current and size of a electrode for a given job.

DRAWING:-

(a) Engineering drawings, use of different types of lines, a drawing symbols. Pertaining to machine components, electrical circuits and building drawings as per Indian standard.

(b) Orthographic views and projections, Visualisation of objects from plan, elevations and end views, Interpretations in terms of dimensions, and materials required, Free-hand sketching.

(c) Isometric drawing:- Interpretation of isometric drawings for estimation and costing of materials & constructional details of the components, machine and equipments, free-hand sketching of isometric drawings.

(d) Reading and interpretation of blue prints and production drawings.

VOCATIONAL PRACTICAL - III

-: WORKSHOP TECHNOLOGY :-

Total Marks : 125

Instructional Time : 150 Hours

SHEET METAL

- Preparation of different types of joints used in ducts (Lock groove; standing seam; Pittsburg Lock and End slip)
- Preparation of small rectangular duct as per drawing.
- Preparation of flexible joints by canvass to connect FAN with DUCT.
- To cut a given stainless steel piece to level surface, Drill it, threading by taps and die by hand

PLUMBING WORK-SHOP

- Threading of G.I. pipes.
- Making different types of Leak proof pipe joints using T, Elbow, Bend unions, Nipples Valves and Reducers

CARPENTARY WORKSHOP :-

- Cutting and sawing of wood using different types of saws.
- Preparation of straight Lap joint, cross joints.
- To prepare Picture frame for window-type Air Conditioner
- SOLDERING of G.I. sheets joints.
- Brazing of copper pipe joints using Blow Lamp and Electric solder.
- Welding of brass joints using gas (Welding Torch).
- Arc Welding of (Lap joint/Butt joints of M.S. sheets and plates.
- Gas welding of copper and Brass components on Black steel pipes and galvanised pipes.

FITTING SHOP:-

- To cut a compressor with Hacksaw or a similar object prepared by welding.
- To prepare joints for welding by filing & hacksawing.
- To Prepare a Threaded hole using Drill & Tap of proper size.

CLASS - XII

VOCATIONAL THEORY - IV

-: AIR CONDITIONING :-

Total Marks : 100
Instructional Time : 120 Hrs.

1. INTRODUCTION :- Cooling and heating for comfort, Airconditioning market, Definition of airconditioning, Use of refrigeration system.

2. PSYCHROMETRIC :- Basic terms. Daltons law of partial pressure. Study of psychrometric chart and its use. Human comfort. Comfort zone. Indoor and outdoor design conditions.

3. BUILDING CONSTRUCTION AND HEAT LOAD FACTORS :- Heat load through buildings; Occupancy loads. Ventilation load. Load due to appliances. Difference in loads for winter and summer airconditioning. Use of insulating materials.

4. PACKAGE AND WINDOW TYPE AIR CONDITIONER :- Specifications and constructional details of compressors and Blowers, Constructional details of Water spray on condenser for effective condensations.

5. CENTRAL AIRCONDITIONING :- Year round airconditioning. Equipment used in different types of airconditioning plants. Duct and chilled water types of systems. Heating system. Source of heat. Heat Pump. De Humi-difiers.

6. EVAPORATIVE COOLINGS :- Different types of desert coolers. Fans used in coolers. Water spraying arrangement and pumps used for this purpose.

7. AIR DISTRIBUTION SYSTEM :- Different types of fans and blowers used for air distribution. Construction and types of ducts used. Duct outlets. Types of air filters. Noise Level, and Air velocities Duct fittings.

8. CONTROLS :- Thermostats; sensing devices. Control circuits. Speed control of motors.

9. INSTALLATION, STARTING AND RUNNING :- Procedure and precautions for starting and running different types of air conditioning systems.

10. AIRCONDITIONING OF LUXURY BUSES AND RAILWAY COACHES :- Source of power, Air distribution, study location of different components.

VOVATIONAL PRACTICAL - IV

Total Marks : 125
Instructional Time : 150 Hours.

-: AIR CONDITIONING :-

DOMESTIC AIR CONDITIONING SYSTEMS

- Install Domestic Air-Conditioning unit
- Test Overload & relay in Window unit
- Test Motor starter
- Test window unit fan motor
- Check & connect window Air-conditioning Electrical circuit
- Add oil to compressor (window unit)
- Evacuate window Air-conditioning unit
- Change refrigerant in window Air-conditioning units.
- Test leaks in window Air-conditioning units.
- Service window Air-conditioning units
- Test & adjust window Air-conditioning units
- Vacuum testing of the whole unit
- Pressure testing of the whole unit with Soap Solution.
- Pressure testing of the whole unit with halide leak detector.
- Checking of oil failure switch
- . Gas charging in different system
- Repair of Expansion of Valve.
- Repair of Solenoid valve.
- Repair of selector switch
- Repair of voltage (shunt) types relay.
- Repair of current (series) type relay.
- Pressure loss in ducts.
- Cleaning of and replacing of filters, Plants.
- Preparation of Brine solution. Ice Plant (Ice Candy)
- To provide and lay different insulation materials on systems.
- Installation of Refrigerator (for All)
- Installation of Window type Air Conditioning (A/c)

Cleaning of different types of opening. (Central Plant)

To determine the humidity of environment using wet bulb dry bulb thermometer, and sling psychometer.

To set and repair Low Pressure & Highe Pressure cut outs.

COMMERCIAL REFRIGERATION SYSTEMS

Test the efficiency of compresser

Charge oil in the compressor

Evacuate the system.

Charge refrigerant in the system.

Test leaks in the system.

Remove & replace Dehydrater.

Remove and replace Heat exchanger

Remove & replace oil separater

Remove, replace & clean Thermostatic Expansion valve strainer.

Service commercial refrigerating system.

Service water cooler (open type)

Service Ice Candy Plant (small unit)

REFRIGERATION CONTROL

Test and adjust Low pressure cutout

Test and adjust High pressure cutout

Test and install check valve

Test and install solenoid valve

Adjust and install Thermostatic Expansion valve

Adjust and install Regulating valve

Service and Repair low side float valve

Service & Repair High side Float valve

Service and Repair Evaporative condenser

Service and Repair Cooling Tower

Service and Repair Water Cooled condenser

Descaling of water cooled and Evaporative condenser

AIR CONDITIONING

- Use sling & Psychrometer to determine Wet Bulb and Dry Bulb Temperature
- Determine Relative Humidity by Psychrometric chart.
- Normal Maintenance routine of Air Conditioning system.
- Seasonal shut down of an Air Conditioning Plant.
- Seasonal starting of an Air Conditioning Plant.
- Evacuate system and test before charging
- Charge refrigerant in Air-Conditioning system
- Final inspection after charging.

VOCATIONAL THEORY - V

MAINTENANCE, SERVICING AND TROUBLE SHOOTING

Total Marks : 100
Instructional Times : 120 Hrs.

INTRODUCTION :- Maintenance Types, Preventive Maintenance of

(1) Compressors (hermetically sealed and open type).

(2) Condensers (Air cooled and Water cooled) including cooling tower Evaporators, piping etc.

SERVICING

Lubrication of units, cleaning and replacement of air filters cleaning/descaling of condensers, Cooling coils.

MAINTENANCE OF COMPRESSOR :-

Assemble and Install the compressor, Levelling of Compressors. Preventive Maintenance of electrical motors electrical controls and circuits. Estimation of time required for repairs. Levelling and Installation of various refrigeration units.

TROUBLE SHOOTING :- Possible causes, and diagnosis and remedial measures. Trouble shooting charts, case studies for Hermetic and Semi-Hermetic Compressors, Thermostatic expansion valves, Relays (cut out and overload) starting and running capacitors, filters, capillary tube etc.

Safety Precautions in maintenance and servicing work.

VOCATIONAL PRACTICAL - V

Total Marks : 150
Instructional Time - 180 Hrs.

SERVICE OPERATIONS (PRACTICAL)

S - 1 To Evacuate the system

S - 2 To remove refrigerant from the system

- (a) Using compressor
- (b) Using pump out unit
- (c) Using Refrigerant cylinder

S - 3 Adjust the thermostatic expansion valve

S - 4 Study of constructional details of hermatic compressor

S - 5 To test a hermatically sealed compressor motor assembly.

MAINTENANCE AND SERVICING (PRACTICALS)

System Operations

1. To Purge Air from/system.
2. To use the halide leak detector.
3. To charge through low side.
4. To determine operating Head Pressures of the system.
5. To check compressor on the Job.

TROUBLE SHOOTING

(a) In Refrigeration Units

1. Not getting start
2. Not getting cold
3. Freezer not working
4. Unit giving shook (while touching)
5. More cooling in Freezer
6. Door not closing properly
7. Bulb not glowing
8. Unit drawing larger current
9. Unit running but in sufficient cooling.
10. Relays defective/not working.
11. Thermostates not working

12. Over loads defective.
13. Compressor defective.
14. Refrigeration leakage in the system.

(b) In Air Conditioning Units

1. A/c not starting
2. Air Fan not starting
3. A/c starting but no cooling
4. Low/ineffective cooling.
5. Motor making noise.
6. Fan blades touching the unit body.
7. Compressor short circuting.
8. Unit drawing large current
9. Thermostatic switch defective / not working
10. Expansion valve defective / not working

PRACTICAL FOR SERVICING OF AIR CONDITIONERS

-: SERVICING :-

1. Disconnect the Refrigerator
2. Clean Air filter
3. Clean Cooling Coil
4. Clean Condenser
5. Clean for Motor's "Bushes ciling etc."
6. The whole Air Conditioner check for loose parts and vibrations etc.
7. Check for water pressure
8. Check for Refrigerant Pressure
9. Descaling of condenser.
10. Descaling of cooling tower
11. Cleaning of spray nozzles
12. Check for temprature
13. Check for Low pressure switch
14. Check for high pressure switch
15. Check for oil pressure switch
16. Check for soleniod valve
17. Air flow in Duct
18. Insulation for different places.

VOCATIONAL THEORY - VI

-: ENTERPRENEURSHIP AND MARKETING (THEORY) :-

Total Marks : 100
Instructional Time ; 120 Hours.

1. **INTRODUCTION :-** Enterpreneurship, definition, types- solo self employed, team builders, acquirers, Buy-sell artists, (spares and repairs service, sales of equipment type). Comparision of self employment with wage employment. Personality traits of an enterprenuer.

   Enterpreneurship and the heritage variable in Indian society. Enterpreneurial development as function of motivation, incentive, expectation and heritage.

2. **TO START AN ENTERPRISE :-** different steps;

   - Need for enterprise, feasibility study preliminary scheme, overall financial assessment, approvals, financial planning, scheme execution, design procurement, construction, commissioning and production/service.

   FEASIBILITY STUDY - Technical

   Problems, market assessment, Budget costs, economic-viability, selection of site, labour types and availability, preliminary programmes/project report;

3. **TO RUN AND SUSTAIN AN ENTERPRISE :-** Mobilizing financial resources, registration of enterprise in corporation, and other taxation and Government departments, procurement of tools and equipment, selection of man powe, book keeping and accounts.

4. **MARKETING STRATEGIES :-** at the enterprise, at the site of the customer, publicity, public relations comparative study of parallel services, products and components and their marketing strategies. Negotiating annual service contracts, Filling & persuing tenders.

5. **SALESMANSHIP :-** Personality traits, estimation of cost and time of providing service, negotiating with customer and procuring orders.

6. **SUCCESS AND FAILURE FACTORS :-** Personality traits, aptitude, integrity and sincerity, knowledge and observance of safety

precautions as advised by experienced enterpreneurs, decision making ability, sensibility to the needs of customers, maintaining relations with concerned officials and financers, seasonal variations in demands vis-a-vis profit margins.

-: VOCATIONAL PRACTICAL - VI

Total Marks : 125,
Instructional Time : 150 Hrs.

-: ENTERPRENEURSHIP AND MARKETING (PRACTICAL) :-

The practicals (experiences) of this subject are intended;

(i) To reinforce the theoretical concepts and principles.

(ii) To develop skills related to development of project report for starting, sustaining and expanding an enterprise.

(iii) To develop personality traits pertaining to enterpreneurship.

EXPERIENCES: (In groups of 5 to 10 students)

1. Interview different types of enterpreneurs around the school.
2. Interview different officials and persons who can assist in starting and sustaining enterprises such as:
   (a) Domestic air conditioners and refrigerators service enterprise.
   (b) Sales of spares plus servicing of domestic appliances
   (c) Sales of equipments, spares plus servicing of domestic appliances.
   (d) Sales of equipments spares and servicing of process appliances - cold storage, ice plants, ice-cream factories, central air conditioning plants etc.
   (e) Study Records Documents, cases
   (f) Prepare a case of successful enterprise.
3. The student will suggest atleast three alternative types of enterprises one of which he would persue in future, in the vocation of refrigeration and air conditioning.
4. Decide one enterprise and involve in the following experiences:

4.1 Conduct market survey using door to door, shop to shop, and interviewing similar enterpreneurs (if any) to determine:

  (a) Potentials for sale, of equipments/spares/ along with make, type and capacity etc.

  (b) Potentials for providing service equipments under warranty period, provision of existing after sales service, most frequent faults etc.

  (c) Prevailing market costs of equipments, spares and service charges.

  (d) Potential competitors and their marketing strategies.

  (e) Make a potential problem analysis.

4.2 Prepare preliminary scheme of enterprise and estimate total capital outlay.

4.3 Discuss with the concerned Government officials and commercial agencies to get the finances and subsides etc.

4.4 Prepare a feasibility report, considering allied aspects.

4.5 Filling applications forms for different formalities to start and sustain the enterprise.

-: LIST OF EQUIPMENT AND RAW MATERIALS :-

ELECTRICAL LABORATORY:

1. Multimeter : AVO, VTVM
2. Megger
3. Ammeter - Moving coil, Moving Iron type
4. Voltammeter
5. Wattmeter
6. Energymeter
7. Voltage stabiliser
8. Circuit breaker
9. Motor starter
10. Thermostat controlled devices
11. Transformer : Single phase - step up & step down
12. Relays - Over current and under voltage relays
13. Different types of fuses
14. Accessories like switches, lampholders, plugs.
15. Different types of conductors, insulators, semi-conductors.
16. Phase tester and test lamps.
17. Electrician's Hand Tools.

REFRIGERATION AND A/C LAB. (TOOLS & EQUIPMENT.)

1. Spaners set (fixed), Ring spanners
2. Slider wrenches (different sizes)
3. Box wrench set
4. Nose plier, Plier, Cutter pliers.
5. Pipe cutters (tube cutter)
6. Pipe benders
7. Flaring Block (or vice)
8. Swaging tool
9. Pinch off tools
10. Hand shut off valve
11. Blow lamp
12. Screw drivers.
13. Vice (bench), pipe
14. Ammeter, Voltmeter, Ohm-meter, thermometer
15. Charging line
16. Pressure gauge, compound gauge, oil gauge
    (0-300 psi) (0-150 psi) (0-200 psi)
17. Micrometer, tachmoter
18. Gas charging unit
19. Vacuum pump
20. CO_2 cylinder, N_2 cylinder
21. Insulating materials
22. Drill-maching (hand or electric, portable)
23. Hammer, Chisel.
24. Oil blower
25. Punch tool
26. Feeler gauge
27. Files. (round, half round, flat, rough, fine)
28. Hack saw
29. Refrigerator, Ice candy, softing M/C, Air conditioner
30. Soldering iron
31. Cup board
32. Helide torch
33. Sling Psychrometer
34. Dry & wet bulb thermometer
35. Different types of charts.
36. Components for demonstration.

37. Compressors of different types
condenser of different types
evaporators of different types
expansion valves of different types
thermostat
Relay
Overload relay
starting and running capacitors
selector switches
reversing valve
fan motors
pumps
churners

TOOLS & EQUIPMENT.

WORKSHOP LAB.

Saws, Hacksaws
Chisels
Vices
Planers
Files
Hammers, wooden hammers, carborundum hammer
Drill machines (Pillar type upto 1", portable upto ½%)
Anvil
Mallets
Cutters
(fusion rods) welding, Blow lamp, Brazing rod
Arc welding set (single phase 5 KV)
Bending press for sheet metals
Marking tools on sheet
MS surface plate (½" thick 2' X 3')
M.S. Plates ½" X 3" X 6' - 2 Nos.
Centre lathe (6")
Plumbing tools (pipe wrenches, threading die, taps,
pipe, vice, Hand trolley.
die and tap set

-: SUGGESTED READING MATERIALS :-

A. A. Air-Conditioning

- PRINCIPLES OF AIR CONDITIONING
  by V. Paul Lang
  Delmar Publishers. Albany, New York
- REFRIGERATION AND AIR-CONDITIONING
  by Air-Conditioning & Refrigeration Institute
  Prentice-Hall, Inc. New Jersy
- BASIC REFRIGERATION AND AIR CONDITIONING
  by Hazara & Chakravarty
  Dhanpat Rai & Sons
  Delhi.
- NEATING VENTILATION AND AIRCONDITIONING PLANT
  planned maintenance & operation
  by J.R. Mulholland
  Business Books Ltd. London.
- REFRIGERATION AIR-CONDITIONING, RANGE AND OVEN SERVICING
  by Robert Scharff
  McCraw Hill Book Co.
  New York, St. Louis, San Francisco.

B. -: WORKSHOP PRACTICE :-

- SHOP THEORY

  by Fred Nicholson

  Mcgraw Hill Book Company
  New York, Toronto, London.

- WORKSHOP FAMILIARISATION

  by E. Wilkinson, Pitman Publishing.

- SHEET METAL Vol. 1 & Vol. 2
  by Philip M. Johnston, D.B. Taraporewala Sons & Co.
  Provate Ltd., Bombay.

- BASIC FABRICATION AND WELDING ENGINEERING

  by - F.J.M. Smith, Longman Group Limited, London.

- WOODS AND WOODWORKING

  by - Delmar W. Olson, Prentice-Hall of India
  Private Ltd., New Delhi.

- Heating and Ventilating for craft studies

  by - Ian G. Gordon, Pub. Newness Butterworths,
  London.

C. REFRIGERATION

1. Basic Refrigeration and Air Conditioning

   P.N. Ananthanarayanan
   Tata Mc Graw Hill

2. Heating and Ventilating for Craft Studies

   I. G. Cordon, Brian Noble

   Newnes - Butterworths London.

3. Refrigeration & Air Conditioning Guide:

   Commercial Refrigeration Audel's Series

D. -: MAINTENANCE SERVICING AND TROUBLE SHOOTING :-

1. Preventive Maintenance

   By A.A. Niazi

   NPC, 38 Golf Links, New Delhi

2. Machine Tool Maintenace & Rebuilding

   by William Perritt and John Lilton

   The Machinary Publishing Co. Ltd. London.

3. Management of Maintenance

   A.A. Niazi, Asia Publishing House, Bombay.

4. Refrigeration Servicing:

   by Celiber, P.F.

   Published by D.B. Taraporewala and sons

   210, D.N. Road, Bombay.

-: BOOKS BY ROBERT SCHARFF :-

- Trouble shooting chart (of refrigerator) -
- Trouble diagnosis for Electrical refrigerator
- Trouble diagnosis for Automatic Ice Maker
- Failure & disposition chart
- How to calculate a Room load
- Air circulation system
- Cycle of refrigeration of room air conditioner
- Performance checking procedure
- Trouble Diagnosis of room air conditioner
- Trouble shooting chart of room air conditioner
- Trouble Diagnosis for Dehumidifiers
- Trouble diagnosis for Pressure water Coolers
- Trouble diagnosis for air cleaner
- Trouble diagnosis for vacuum cleaning system

E. -: ENTERPRENEURSHIP :-

1. Enterprise and society
by Viyashil Gautam
Pub: Concept Publishing Co. Delhi.

2. Study of selected small industrial units,
Pub: National Council of Applied Economic Research,
New Delhi.

3. New Venture strategies
by Karl H. Vasper
Pub: Prentice Hall INC Englewood cliffs.

4. Management of Engg. Projects
by Maurice Snowdon
Pub: Newnes Butterworths, London

5. Developing Entrepreneurship
by Udai Pareek and T. Venkateswara Rao AHB
Printer SANJIV PRINTERY
Mirzapur, Ahmedabad.

6. Production Planning Control and Industrial Management
by Jain & Agarwal, Khanna Pub, Delhi.

7. Text book of Industrial Engg.,
by Mansoor Ali & Delela
Pub: Standard Pub., distributors, New Delhi.

8. Related case-studies, Project reports, documents,
Government procedures, films, slide-tape sequences,
video-programmes etc.